

General Disclaimer

One or more of the Following Statements may affect this Document

- This document has been reproduced from the best copy furnished by the organizational source. It is being released in the interest of making available as much information as possible.
- This document may contain data, which exceeds the sheet parameters. It was furnished in this condition by the organizational source and is the best copy available.
- This document may contain tone-on-tone or color graphs, charts and/or pictures, which have been reproduced in black and white.
- This document is paginated as submitted by the original source.
- Portions of this document are not fully legible due to the historical nature of some of the material. However, it is the best reproduction available from the original submission.

LACIE-C00200
VOLUME IA (REV. A)
JSC-09873

7.9-10108
TM-79972

LARGE AREA CROP INVENTORY EXPERIMENT (LACIE)

N79-18377

HC A03 MF A01
Unclas
G3/43 00108
Under NASA sponsorship
of early and wide dis-
tribution of Earth Resources Survey
information and without
any use made thereof.



NASA NOAA USDA

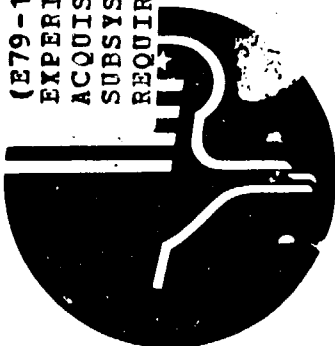
Level 3 Baseline

DATA ACQUISITION, PREPROCESSING
AND TRANSMISSION SUBSYSTEM
(DAPTS) - LANDSAT DATA REQUIREMENTS

NOTICE: THIS IS A BASELINED LEVEL 3 DOCUMENT CON-
TROLLED BY THE LACIE LEVEL 3 CHANGE CONTROL BOARD.
ANY PROPOSED CHANGES SHOULD BE DOCUMENTED ON AN
RECP FORM AND TRANSMITTED TO R. B. MACDONALD,
LACIE MANAGER, NASA-JSC, CODE TF, HOUSTON, TEXAS 77058.

National Aeronautics and Space Administration
LYNDON B. JOHNSON SPACE CENTER

Houston, Texas
December, 1975



REVISIONS

REV LTR	CHANGE NO.	DESCRIPTION	DATE
A	5M0050	BASELINE ISSUE (Reference CCBD #III-0001, dated December 16, 1974)*	12-16-74
		Complete revision due to project rescopng	12-16-75
*The changes required by the following RID's which were approved during the LACIE Project Review conducted December 3 through 5, 1974, have been incorporated into this baseline issue of the LACIE Level III Requirements Documents: 0-2 through 0-13, 0-15 through 0-29, and 0-31 through 0-46 1a-1, 1a-2, 1a-10, 1a-21, 1a-34, and 1a-36 1b-3 and 1b-6 1c-2, 1c-4, 1c-5, 1c-9, 1c-10, 1c-13, 1c-16, 1c-17, and 1c-20 2-12a, 2-13, 2-17, and 2-27 All other changes required by the remaining RID's approved during the Project Review will be incorporated by transmitting an RECP to the LACIE Level III Change Control Board for approval. Each RECP should be accompanied by the appropriate RID Closeout Form as described during the Project Review.			

LIST OF EFFECTIVE PAGES

The current status of all pages in this document is as shown below:

<u>Page No.</u>	<u>LACIE Change Date</u>	<u>Authorizing CCBD No.</u>
<u>ii</u>	Baseline 12/16/75	5M0050
<u>iii</u>	3/18/77	5M0018
<u>iv</u> through <u>x</u>	Baseline 12/16/75	5M0050
<u>1-1</u> through <u>4-2</u>	Baseline 12/16/75	5M0050
<u>4-3</u>	2/13/76	5M0066
<u>4-4</u>	Baseline 12/16/75	5M0050
<u>4-5</u>	3/18/77	5M0018
<u>4-6</u> through <u>6-1</u>	Baseline 12/16/75	5M0050
<u>6-2</u>	2/13/76	5M0066
<u>6-3</u> through <u>11-2</u>	Baseline 12/16/75	5M0050

FOREWORD

Efficient management of the Large Area Crop Inventory Experiment (LACIE) dictates that effective controls of project activities be established. To provide a basis for effective control, documentation will be prepared, baselines will be established, and changes to the baseline will be subsequently controlled by the proper management levels.

The specific control documents which will be used are defined in the LACIE Project Plan, LACIE-C00605. All elements of the LACIE Project must adhere to these baselined control documents, and, where it is considered that the requirements should be changed, the proper change request, accompanied by a full justification, must be submitted to the proper management level in accordance with established procedures. These documents will be maintained current by change notices and revisions, as required. Each change notice and/or revision will reference the applicable Change Control Board Directive (CCBD) which approved the change.

This document, LACIE-C00200, Volume IA, Revision A, was formerly entitled the LACIE Data Acquisition, Preprocessing, and Transmission Subsystem (DAPTS) - ERTS Data Requirements. It defines DAPTS Landsat Data Requirements and has been prepared in accordance with the "Instructions for Preparation of LACIE Requirements Documents", LACIE-00100, Revision C, dated November 20, 1974. "Full-Up System", as used in this document, is defined as the system required to accomplish LACIE Phase II. In general, the approach used in each section is to first specify the requirements of the Full-Up System and then to specify the requirements of any interim systems by reference to specific paragraphs in the Full-Up System requirements sections of the document. The LACIE Project Phases are defined in the LACIE Project Plan.

The organization responsible for the implementation of each requirement defined in this document is specified on an individual requirement basis. Where the implementation responsibility applies to the complete section, the implementation responsibility is specified after the section title. A "section" for the purposes of designating implementation responsibility is defined as being any numbered paragraph and

all subparagraphs. Where different implementation responsibilities apply to different portions of a section, the implementation responsibility is specified on an individual paragraph or sentence basis, as applicable. All implementing organizations designated shall accomplish their implementation activities in accordance with the requirements specified herein.



for R. B. MacDonald
Manager, Large Area Crop Inventory Experiment

CONTENTS

Section		Page
1.0	<u>FUNCTIONAL RESPONSIBILITIES</u>	1-1
1.1	<u>GENERAL</u>	1-1
1.2	<u>SPECIFIC</u>	1-1
2.0	<u>APPLICABLE DOCUMENTS</u>	2-1
3.0	<u>FUNCTIONAL FLOW DIAGRAMS</u>	3-1
3.1	DAPTS LANDSAT 1/2 SUBSYSTEM	
	DEVELOPMENT	3-1
3.1.1	<u>Full-Up System</u>	3-1
3.1.2	<u>Interim Systems</u>	3-1
3.2	DAPTS LANDSAT 1/2 SUBSYSTEM	
	OPERATION	3-1
3.2.1	<u>Full-Up System</u>	3-1
3.2.2	<u>Interim Systems</u>	3-1
4.0	<u>REQUIREMENTS (CONSOLIDATED)</u>	4-1
4.1	<u>FULL-UP SYSTEM</u>	4-1
4.1.1	<u>Current Requirements</u>	4-1
4.1.2	<u>Possible Future Requirements</u>	4-6
4.2	<u>INTERIM SYSTEMS</u>	4-7
4.3	<u>METRIC CONVERSION</u>	4-7
5.0	<u>INPUT REQUIREMENTS</u>	5-1
5.1	<u>FULL-UP SYSTEM</u>	5-1
5.1.1	<u>DAPTS</u>	5-1
5.1.2	<u>CAMS</u>	5-1
5.1.3	<u>YES</u>	5-1
5.1.4	<u>CAS</u>	5-2
5.1.5	<u>ISRRS</u>	5-2
5.1.6	<u>SPE</u>	5-3
5.1.7	<u>IE</u>	5-3
5.1.8	<u>Research</u>	5-3
5.1.9	<u>Test and Evaluation</u>	5-3
5.2	<u>INTERIM SYSTEMS</u>	5-3
6.0	<u>OUTPUT PRODUCTS</u>	6-1
6.1	<u>FULL-UP SYSTEM</u>	6-1
6.1.1	<u>DAPTS (Interim Output Products)</u>	6-1
6.1.2	<u>CAMS</u>	6-2
6.1.3	<u>YES</u>	6-4
6.1.4	<u>CAS</u>	6-5
6.1.5	<u>ISRRS</u>	6-5
6.1.6	<u>SPE</u>	6-5
6.1.7	<u>IE</u>	6-6
6.1.8	<u>Research</u>	6-6
6.1.9	<u>Test and Evaluation</u>	6-6
6.1.10	<u>Accuracy Assessment</u>	6-7
6.2	<u>INTERIM SYSTEMS</u>	6-7

7.0	<u>INTERFACE REQUIREMENTS (DOCUMENTS)</u> . . .	7-1
8.0	<u>OPERATIONAL REQUIREMENTS AFFECTING</u>	
	<u>THE DESIGN</u>	8-1
8.1	THROUGHPUT REQUIREMENTS	8-1
8.2	RESPONSE REQUIREMENTS	8-1
8.3	RELIABILITY REQUIREMENTS	8-1
8.3.1	<u>General Reliability</u>	8-1
8.3.2	<u>Hardware Reliability</u>	8-1
8.3.3	<u>Software Reliability</u>	8-2
8.4	SECURITY REQUIREMENTS	8-2
8.5	DELIVERY REQUIREMENTS	8-2
8.6	QUALITY ASSURANCE (QA)	
	REQUIREMENTS	8-2
8.6.1	<u>General Requirements</u>	8-2
8.6.2	<u>Specific Requirements (DAPTS)</u>	8-4
8.7	OTHER OPERATIONAL REQUIREMENTS	8-7
8.7.1	<u>General Precautions</u>	8-7
8.7.2	<u>Data Receipt</u>	8-7
8.7.3	<u>Data Accountability</u>	8-8
8.7.4	<u>Transmittal of Data Products</u>	8-8
9.0	<u>VERIFICATION REQUIREMENTS</u>	9-1
10.0	<u>RESEARCH REQUIREMENTS</u>	10-1
11.0	<u>TEST AND EVALUATION REQUIREMENTS</u>	11-1

CHECK
 OF QUALITY

FIGURES

Figure		Page
3-1	DAPTS Landsat 1/2 subsystem simplified development flow diagram	3-2
3-2	DAPTS simplified operational flow diagram	3-3

GLOSSARY

ADP	Automatic Data Processing
ASVB	Application System Verification Branch
CAMS	Classification and Mensuration Subsystem
CAS	Crop Assessment Subsystem
CCT	Computer Compatible Tape
COD	Center Operations Directorate
DAPTS	Data Acquisition Preprocessing and Trans- mission Subsystem
DR	Discrepancy Report
DSAD	Data Systems and Analysis Directorate
EOD	Earth Observations Division
EOF	End-of-File
ERIPS	Earth Resources Information Processing System
ERTS	Earth Resources Technology Satellite
FSO	Facilities Support Office (EOD)
Full-Up System	The system required to accomplish LACIE Phase II
GSFC	Goddard Space Flight Center
ICD	Interface Control Document
IE	Information Evaluation
Interim Systems	System requirements to accomplish subphases of LACIE Phase I excluding subphases IA and IB
ISRRS	Integrated Storage, Retrieval, and Reformatting Subsystem
ISS	Intensive Study Sites

JSC	Johnson Space Center
JSC Inter- face Tape	A CCT compiled at JSC to initiate the GSFC preprocessing system or revise a previous order for preprocessing.
LACIE	Large Area Crop Inventory Experiment
Landsat	Land Satellite (formerly ERTS)
IEC	Lockheed Electronics Company
MSS	Multispectral Scanner
MTU	Magnetic Tape Unit
NASA	National Aeronautics and Space Administration
NDPF	NASA Data Processing Facility
NOAA	National Oceanic and Atmospheric Administration
PFC	Production Film Converter
QA	Quality Assurance
RTCC	Real-Time Computer Complex
SEAD	Science & Applications Directorate
SPE	System Performance Evaluation
TBD	To Be Determined
WMO	Worldwide Meteorological Organization
YES	Yield Estimate Subsystem

SECTION 1.0 FUNCTIONAL RESPONSIBILITIES

1.1

GENERAL

DAPTS is responsible for the acquisition, preprocessing, and transmission of the data necessary to fulfill the data requirements of the LACIE operation. Categories of data to be acquired, as well as details such as quality, quantity, frequency, and time of acquisition, will be defined to the Data Acquisition Subsystem by the other subsystem and the supporting Research, Test, and Evaluation (RT&E) elements.

1.2

SPECIFIC

The specific responsibilities of DAPTS for Landsat 1/Landsat 2 data include assimilating requirements for Landsat data, scheduling the Landsat spacecraft, acquiring the data, preprocessing the Landsat data, and transmitting the data to the Integrated Storage, Retrieval, and Reformatting Subsystem (ISRRS). Preprocessing includes those operations such as extraction of sample segments and registration of temporal data, which are necessary before the data is used by any of the other subsystems or supporting RT&E elements.

SECTION 2.0
APPLICABLE DOCUMENTS

The following documents are applicable to the extent specified herein:

- A. GSFC/JSC Interface Control Document, dated March 20, 1975.
- B. LACIE Operations Handbook, dated: TBD.
- C. LACIE Project Plan, LACIE-C00605, dated August, 1975.
- D. Instructions for Preparation of LACIE Requirements Documents, LACIE-C0100, Revision C, dated October 25, 1974.

PRECEDING PAGE BLANK NOT SHOWN

SECTION 3.0
FUNCTIONAL FLOW DIAGRAMS

3.1 DAPTS LANDSAT 1/2 SUBSYSTEM DEVELOPMENT

3.1.1 Full-Up System

The functional flow diagram for the development of the portion of DAPTS related to Landsat data is presented in figure 3-1.

3.1.2 Interim Systems

The functional flow diagram for the development of the portion of DAPTS related to the processing of Landsat data for the interim systems is the same as for the full-up system described in 3.1.1.

3.2 DAPTS LANDSAT 1/2 SUBSYSTEM OPERATION

3.2.1 Full-Up System

The functional flow diagram for the operation of the portion of DAPTS related to Landsat data is presented in figure 3-2.

3.2.2 Interim Systems

The functional flow diagram for the operation of the DAPTS related to Landsat data for the interim systems is the same as for the full-up system described in 3.2.1.

PRECEDING PAGE BLANK NOT SHOWN

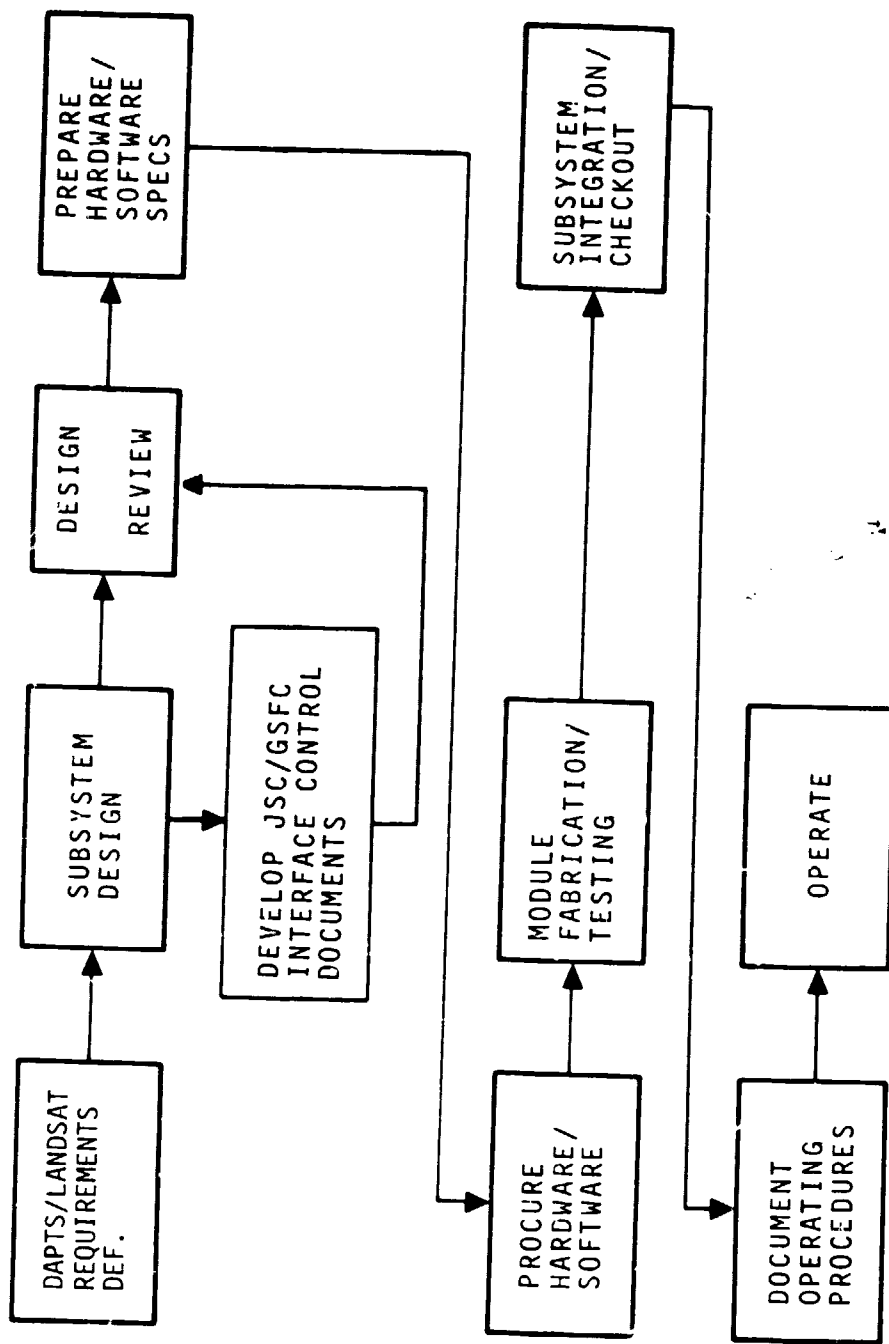


Figure 3-1.- DAPTS Landsat 1/2 subsystem simplified development flow diagram.

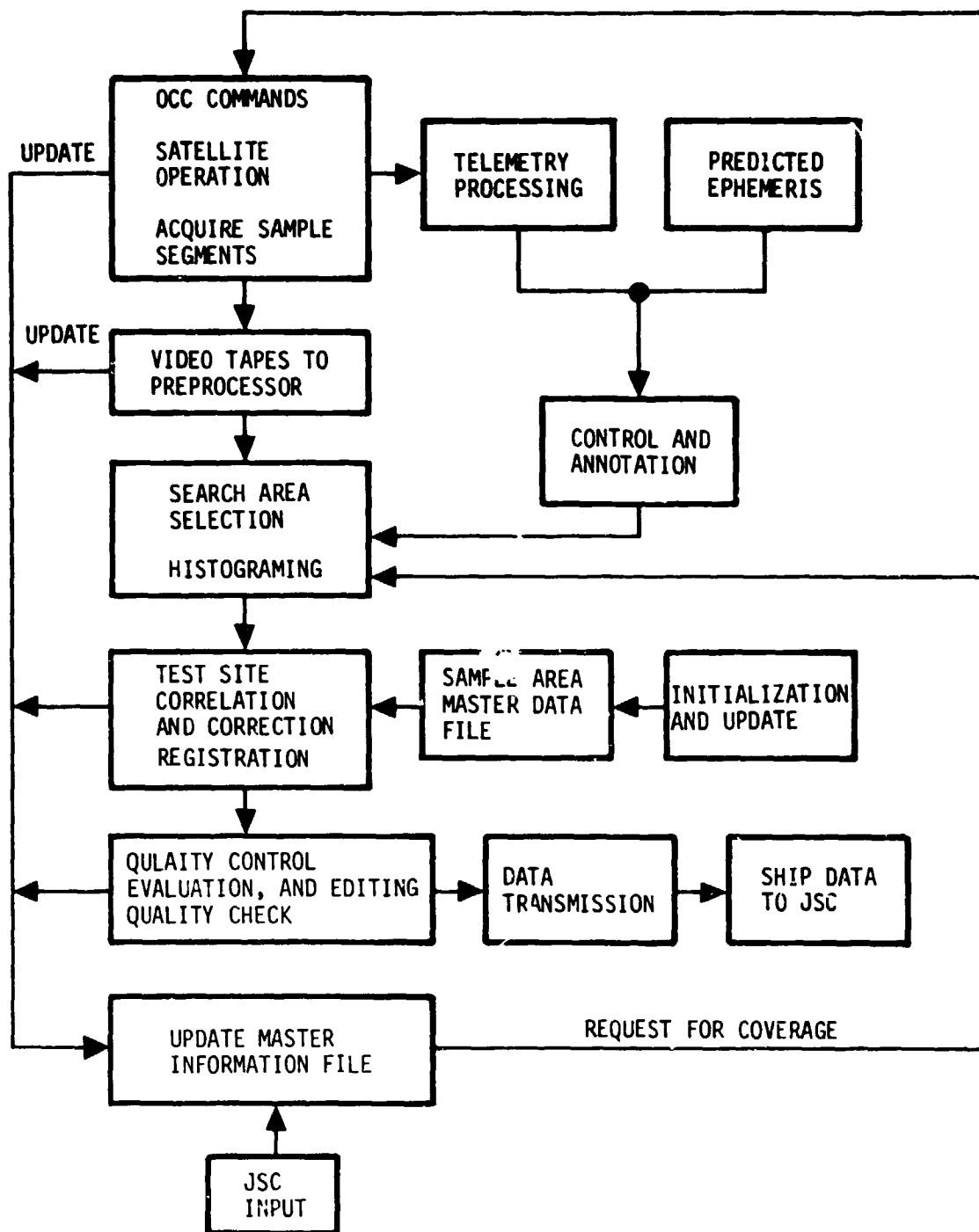


Figure 3-2.- DAPTS simplified operational flow diagram.

~~PRECEDING PAGE BLANK: NOT CLARIFIED~~

SECTION 4.0 REQUIREMENTS (CONSOLIDATED)

4.1

PULL-UP SYSTEM

The Goddard Space Flight Center (GSFC) will acquire and extract portions of specified Landsat passes, register these segments with previously acquired data of the same areas, and transmit computer-compatible tapes (CCT's) containing the registered sample segments to the Johnson Space Center (JSC). The JSC will define the locations and time periods for the acquisition of the sample segments.

4.1.1

Current Requirements

The requirements exists to acquire and preprocess 4800 sample segments, 5 x 6 nm (9 x 11 km) each, at least four times per year. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

The initial selection of segment locations shall be made at the JSC, using the approved LACIE sampling strategy. (Required by DAPTS; Category 1; Implementation Responsibility: CAS). The biological windows, four per growing season, during which data is to be acquired, must be designated. (Required by DAPTS; Category 1; Implementation Responsibility: YES)

From a list of randomly selected potential sample segments, a final selection shall be made. This selection will consider various constraints, discussed below, and the output of this step shall be the latitude and longitude of the segment center to the nearest minute, and a number for each sample segment. (Required by DAPTS; Category 1; Implementation Responsibility: CAS/NASA-S&AD/FSO).

A subset of the 4800 sample segments, nominally 960 segments, shall be designated as training segments. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS). These segments shall receive preprocessing at each opportunity in all biological phases. (Required by CAMS; Category 1; Implementation

Responsibility: DAPTS/NASA-GSFC). For each section designated a training segment, the Production Film Converter (PFC) flag shall be set on the coding sheet. After the first successful preprocessing of each training segment during each biological window, this film production flag will be cancelled. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS). In addition, all sample segment numbering and coordinate information, biological phase definition, color code data for the PFC, country data and other applicable data for each sample segment shall be entered on computer input coding sheets in the format specified in the JSC/GSFC Interface Control Document (ICD). (Required by DAPTS; Category 1; Implementation Responsibility: CAS). This ICD has been negotiated prior to the beginning of Phase II by the data processing elements of JSC and GSFC. The document defines the physical interface between JSC and GSFC for data being transmitted between the two organizations and contains complete documentation of the format to be used for the two-way data flow. (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD/NASA-GSFC).

An interface tape shall be compiled from the information contained on the aforementioned coding sheets. (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD). This tape, in the format specified in the ICD, shall be transmitted to the GSFC, using methods contained in the LACIE Operational Handbook. (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD).

GSFC will then establish the reference set of data for the particular sample segment by extracting the appropriate number of lines and samples from a Landsat pass over the designated area. Ephemeris and attitude data will be used to determine the specified location of the sample segment. GSFC shall extract the reference sample segment so that the 6-nm (11 km) edge is parallel to the scan line and the 5-nm (9 km) edge is parallel to the ground

- track. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC). Constraints on sample segment location within a Landsat frame include the following:
- A. Sample segments shall fall within the central 80 nm (148 km) of the Landsat scene in an east-west direction.
 - B. A maximum of four sample segments in an east-west direction can be processed, and the centers of the segments must be separated by ± 11 nm (20 km) in the crosstrack direction.
 - C. A maximum of eight sample segments in the north/south or along-track direction can be processed from a given Landsat scene, and the sample segment centers must be separated by ± 10.5 nm (20 km) in the along-track direction.

GSFC shall identify those portions of passes specified by the JSC which contain the sample scenes and will extract portions of the record containing the areas of interest. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

As a subset of the regular sample segments, GSFC will acquire and preprocess the data from approximately 960 training segments, once for each Landsat cycle during the growing season, or approximately 10 times per year.

GSFC shall also acquire and preprocess the data for approximately 37 intensive study areas. These sites will occur in Canada and the United States and shall require that the data be collected and processed at least once each Landsat cycle. (Required by CAMS; Category 1; Implementation Responsibility: {DAPTS-NASA/GSFC}).

During the preprocessing phase, a histogram of the data in each of the four channels shall be compiled by GSFC. This histogram shall apply preferably to only the 5- x 6-nm (9 x 11 km) area covered by the reference set of data; however, a histogram based on the 10- x 11-nm (18.5 x 20 km) area containing the reference

set will be acceptable. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC). JSC shall supply an algorithm for computing Production Film Recorder bias and scaling factors from the histogram data. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS). These factors shall be included in the header information as contained in the ICD. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

The CCT containing the new data will then be automatically correlated with the CCT containing the reference sample segment. A transformation polynomial will be generated to transform the new data set into line and sample congruence with the reference data set. The new data set shall correspond to the reference data set in terms of the number of lines and samples. The RMS registration error between each new data set and the reference data set, for the ensemble of pixels in a sample segment, shall not exceed one pixel. This registration step will result in all subsequent data sets for a given sample segment having line sample correspondence to the reference data set; that is, line 1, sample s on the nth data set will represent the sample point on the ground as line 1, sample s on the reference data set. An edit tape will be prepared for all new scenes collected within a specified period. This tape will include appropriate header records as specified in the ICD. Format and transmittal of the edit tapes will be governed by the ICD. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

GSFC shall perform various quality checks during the preprocessing of the Landsat data. The checks shall encompass cloud cover, data dropout, and registration. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

D. Cloud Cover Check - The data shall be screened for cloud cover. The basic limitation on an acceptable percentage of cloud cover shall be dictated by

1
ORIGINAL PAGE IS
OF POOR QUALITY

limitations imposed by the correlation algorithm and/or visual screening. This limiting percentage is expected to be about 10 percent. Provisions should be made for processing limited data sets containing high percentages of cloud cover by performing manual registration.

- E. Data Dropout - The data shall be screened for dropout of lines of data. Marginal data, defined as data having any dropout, shall be forwarded with a notation in the header indicating the number of lines of data having any dropout. Attempts to replace marginal data shall be made by JSC ordering additional processing from GSFC.
- F. Registration - Parameters given a measure of the correlation peak sharpness, the normalized peak-to-background ratio, and an indication when manually assisted registration is performed shall be included in the header record.

Resource Expenditures shall be reported in terms of manpower, computer time, and material usage required to operate the GSFC portion of DAPTS. (Required by SPE; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

Data Status shall be reported weekly in terms of number of attempted sample segment acquisitions, number acquired, number preprocessed, number of segments shipped to JSC, and the number of segments reordered. (Required by SPE; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

Landsat MSS Calibration Procedures will be documented, including the procedure for replacement of data due to out-of-sync conditions, and the relationship of the radiometric error versus signal strength or spectral energy level. (Required by CAS; Category 3; Implementation Responsibility: DAPTS/NASA-GSFC).

Landsat MSS Registration Procedures will be documented to include the procedures for the automatic and manual processes, an error analysis study supporting the fulfillment of registration accuracy requirements, and further definition of the origin of the header record information pertaining to registration. (Required by CAS Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

A periodic Registration Accuracy Report will be prepared, documenting the registration accuracy achieved in the GSFC registration process. (Required by CAS; Category 2; Implementation Responsibility: DAPTS/NASA-DSAD).

Data shall be processed through the preprocessing and transmission portions of the LACIE system so that it is available at the JSC for further analysis by time of acquisition plus 10 days. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

If a data deficiency is discovered during subsequent processing of the data at the JSC, a change order will be initiated. Changes to the basic data order initiated by the JSC Interface Tape will be made by filling out coding forms in the format specified in the ICD for change cards. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS). Segments can be deleted or added. Additional processing can be specified for a segment in a given biological window (for example, an attempt can be made to rerun the original data or obtain a replacement for a marginal data set). Film processing flags can be changed, color code information can be changed, and biological windows can be updated.

4.1.2

Possible Future Requirements

(Req'd by CAS; Cat 4; Impl. Resp.: DAPTS/GSFC)
Registered full-frame Landsat data may be required. The initial use of the registered frames may be to provide registered data from which 5- x 6-nm (9 x 11 km) sample segments can be extracted. Subsequently, the full-frame

registration capability could support a variety of different sampling techniques that might be employed in later phases of LACIE.

4.2

INTERIM SYSTEMS

Phases 1A and 1B: The requirements for phases 1A and 1B are the same as the above requirements for the full-up system with the following exceptions:

Phase 1A: The data to be processed is retrospective Landsat 1 data and will be selected from data acquired during the 1973-1974 growing seasons. The data sets to be processed will be specified by the JSC. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS/CAS). GSFC will establish the capability to exercise the DAPIS processing hardware/software using retrospective data as input. (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

The Research Test and Evaluation effort has a requirement for Landsat 1 retrospective data in continuous coverage format as contained on the standard Landsat 1 CCT. These data will be specified to GSFC in the normal manner for ordering Landsat 1 data. (Required by Test and Evaluation; Category 1; Implementation Responsibility: DAPTS). GSFC will fill these orders in the same manner as used for standard Landsat 1 products. (Required by Test and Evaluation; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).

4.3

METRIC CONVERSION

The length units of nautical miles (nm) have the approximate equivalent metric units of kilometers (km), added to conform to new standards. A conversion factor of 1.852 is used to convert nautical miles to kilometers ($\text{nm} \times 1.852 = \text{km}$). The resultant kilometer is rounded off to the nearest 0.5 kilometer.

ORIGINAL PAGE IS
OF POOR QUALITY

~~PRECEDING PAGE BEING NOT SLAM~~

ORIGINAL PAGE IS
OF POOR QUALITY

SECTION 5.0
INPUT REQUIREMENTS

Inputs required by DAPTS from the other LACIE functional elements are defined in the following subparagraphs.

5.1 FULL-UP SYSTEM

5.1.1 DAPTS
Not applicable.

5.1.2 CAMS
List of Training Segments - CAMS shall specify, by segment number, those segments designated as training segments. This designation shall occur for up to 960 of the sample segments. (Category 1; Implementation Responsibility: CAMS).

PFC Gain and Bias Computation Algorithm - CAMS shall provide the algorithm to be implemented by GSFC in computing the gain and bias settings for the PFC (Category 1; Implementation Responsibility: CAMS).

Changes to GSFC Data Orders (Computer Card Coding Sheets) - CAMS shall implement the requests for changing the data acquisition and preprocessing order to GSFC. These changes will include specifying a need for additional processing of a sample segment for a given biological phase, adding or deleting sample segments, changing film processing flags, and changing color code information. The change will be specified by making the appropriate entries on a computer card coding sheet, using the format contained in the JSC card format documentation. These changes will then be submitted through the EOD Data Manager. (Category 1; Implementation Responsibility: CAMS).

5.1.3 YES (Cat. 1; Impl. Resp.: YES)
List of Sample Segment Biological Windows (Computer Card Coding Sheets) - Specific biological windows, during which acquisition and preprocessing of data is desired, will be

specified. A beginning and ending date for each of four biological windows will be specified and entered on computer coding sheets in the format specified by the JSC card format documentation. The dates specified are inclusive and begin and end at 0001 and 2400 hours GMT, respectively. For consecutive windows, the beginning of the follow-on window must be at least 1 day after the end of the window. The same date will not be used for the end of one window and the beginning of another.

5.1.4

CAS

List of Sample Segment Numbers and Coordinates (Computer Card Coding Sheets) - CAS shall implement the LACIE sampling strategy and select and provide to DAPTS the geographic coordinates (center latitude and longitude) of 4800 numbered sample segments. The coordinates will be specified in degrees and minutes (to the nearest minute) of latitude and longitude. Selected sites will have been judged against all system constraints (see section 4.1.1) and found acceptable. The data will be supplied to DAPTS through entry on computer card coding forms in the format specified in the JSC card format documentation.

GSFC Data Order (Computer Card Coding Sheets) - The CAS shall be responsible for preparing computer coding sheets containing all sample segment data needed to activate the GSFC acquisition and preprocessing of Landsat data. These coding sheets will be prepared in the format specified by the JSC card format documentation and will contain such information as the segment number, location, training site designation, definition of biological windows, and color code information for the PFC. Inputs will be obtained from CAMS, YES, and other subsystems as appropriate. Completed forms will be provided the EOD Data Manager for transmittal to DSAD and subsequent preparation of the JSC-GSFC Interface Tape. (Category 1; Implementation Responsibility: CAS).

5.1.5

ISRRS

Not applicable.

- 5.1.6 SPE
Not applicable.
- 5.1.7 IE
Not applicable.
- 5.1.8 Research (Cat. 3; Impl. Resp.: Research)
Landsat Full-Frame Data Orders - The inhouse and sponsored LACIE research program will periodically require full-frame or extended coverage Landsat data. These requirements will be filled by ordering standard CCT's through channels set up for principal investigators. Research requirements must be specified in the LACIE requirements documents with information of sufficient detail as to location, number of scenes, scene ID's, if available, and other data pertinent to the requirement.
- 5.1.9 Test and Evaluation
(Cat. 3; Impl. Resp.: Test and Eval.)
Landsat Full-Frame Data Orders - The test and evaluation effort will periodically require extended coverage not available from the 5- x 6-nm (9 x 11 km) segments normally processed for LACIE Orders for standard Landsat CCT's will be made to fill these requirements. T&E must identify, in terms of quantity and frequency of need, its requirement for such data. As the requirement becomes firm, specific areas of coverage, scene ID's, and other pertinent information must be provided to DAPTS. Data orders will be levied against GSPC using procedures developed for supporting Principal Investigators for ordering Landsat 1 data.
- 5.2 INTERIM SYSTEMS
The DAPTS input requirements for Interim Systems are the same as for the full-up system.

~~PRECEDING PAGE BLANK: NOT A~~

SECTION 6.0 OUTPUT PRODUCTS

Outputs from DAPTS which will be provided to the other LACIE functional elements are defined in the following subparagraphs.

6.1 FULL-UP SYSTEM

6.1.1 DAPTS (Interim Output Products)

The following interim output products will be generated by DAPTS for subsequent use in performing DAPTS functions:

- A. GSFC/JSC Interface Control Document
(Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD/NASA-GSFC) - An Interface Control Document has been negotiated between JSC and GSFC to specify the physical interface for the transmission of LACIE data between JSC and GSFC and between GSFC and JSC. The ICD specifies the location and format for each element of data to be transmitted.
- B. JSC Interface Tape (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD) - An interface tape containing all information such as sample segment number, geographic position, biological window dates, and other information specified in the JSC-GSFC Interface Control Document shall be prepared and forwarded to GSFC to activate the GSFC acquisition and preprocessing operation.
- C. Landsat MSS Data (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Acquire Landsat MSS data over sample segments specified in the JSC-GSFC interface tape and subsequent updates.
- D. LACIE Reference Segments (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Establish a reference 5- x 6-nm (9 x 11 km) segment at each specified sample segment location. This reference segment will be processed for evaluation as well as stored to support the registration of subsequently acquired data over the sample segment.

- E. Landsat MSS Search Area Data (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Extract search areas of 10- x 11-nm (18.5 x 20 km) size, using ephemeris and attitude information, of subsequent data acquisitions over the specified sample segments.
- F. Landsat MSS Registered Data (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Register all data sets over a given sample segment to the reference data set previously established for the sample segment. The RMS registration error between each new data set and the reference data set, for the ensemble of pixels in a sample segment, shall not exceed one pixel.
- G. Landsat MSS Data Quality Reports (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Perform quality control of the preprocessing operation consisting of a cloud cover check, a check for data dropout, and a check for adequacy of registration as detailed in section 4.1.1.
- H. Landsat MSS Data Edit Tapes (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC) - Perform the above operations for the 4800 sample segments, including 960 training segments and 37 intensive study sites, and transmit and edit tape to JSC on a daily or near-daily basis, containing the output of the preprocessing operation. The edit tape shall be formatted and transmitted as specified in the ICD.

6.1.2

CAMS

- A. Landsat MSS Segment Data (CCT) (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - These data will consist of four channels of Landsat multispectral scanner data extracted to cover the 5- x 6-nm (9 x 11 km) sample segments specified in the JSC interface tape. Data will be in the format

described by the JSC-GSFC Interface Control Document.

Segments shall be of two types, ordinary segments and designated training segments. The acquisition and preprocessing of ordinary segments is required in each of four time periods unless such acquisition is prevented by cloud cover, technical problems or operational problems. The acquisition and preprocessing of designated training segments is required for each of up to 16 opportunities per year unless:

1. Acquisition is prevented by cloud cover, technical problems, or operational problems.
2. Acquisition occurs within two days after a previous successful acquisition.

The total number of such segments, up to 4800, shall be determined by CAS. Of these segments, no more than 960 may be designated training segments at any one time; however, the system shall be designed such that any segment may be made a designated training segment or ordinary segment at any time, as long as this does not result in more than 960 active designated training segments.

When a sample segment maintains the same nominal position in two succeeding crop years, its actual position shall be registered within TBD pixels. (Category 1; Implementation Responsibility: DAPTS).

Capability to change any JSC defined parameters associated with a sample segment, or to order reacquisition of data, shall be provided.

- B. PPC Gain and Bias Factors (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - Gain and bias factors shall be computed in the preprocessing operation and included as part of the header record, for the purpose of controlling the gain and bias settings on the production film converter. These factors shall be computed using an algorithm supplied by CAMS.
- C. Regular Landsat Imagery (Required by CAMS; Category 1; Implementation Responsibility:

PSO) - A 1:1,000,000 scale Landsat (9" x 9") image of each Landsat frame used in LACIE is required once each growing season. This image shall be a CIR composite of bands 4, 5, and 7. The image should contain less than 20 percent cloud cover. These images are to be stored by the ISRRS. Access to approximately 40 frames/day is required.

- D. Mosaics (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-SEAD-PSO) - Black and white uncontrolled 1:1,000,000 scale mosaics of each of the LACIE counting wheat growing regions are required. These mosaics shall be available before the start of analysis in any individual country. Each mosaic should be compiled using band 5 (the red band) from imagery acquired during the wheat growing seasons. Two sets of each mosaic are required, one for the ADP country analysis group and one for the image analysis group. These shall be on a stable base.

For each major wheat growing region a north-to-south set of uncontrolled strip mosaic is required. This mosaic shall also be at a scale of 1:1,000,000, but should be compiled from a CIR composite of Landsat bands 4, 5, and 7. Each mosaic shall be compiled from a single Landsat pass acquired once during each biological phase using an average or mid-latitude of wheat region crop calendar to select the actual calendar time to make the data acquisition. Each image used should contain less than 20 percent cloud cover.

6.1.3

YES

Yield and Crop Progression Data (Required by YES; Category 4; Implementation Responsibility: DAPTS) To apply Landsat data for determination of yield and crop progression during Phase II, it is necessary that selected portions of the data be made available to YES for remote determination of yield and crop progression developed by the research effort. No special acquisition or preprocessing is anticipated at this time.

ORIGINAL PAGE IS
OF POOR QUALITY

6.1.4

CAS

- A. Landsat Mosaics (Required by CAS; Category 1; Implementation Responsibility: DAPTS) - Uncontrolled Landsat 2 mosaics of MSS-5 for "green phase" of wheat growth stage a 1:1,000,000 scale of the Phase II LACIE regions are required 60 days prior to the start of Phase II.
- B. Sample Segment Status Report (Required by CAS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - Sample Segment Status Report is required daily. Status of 4800 sample segments shown as data of Landsat data acquisition, wheat growth stage, acquired - not classified, acquired - classified, acquired - classified unsuitable, acquired - backlogged, not required.

6.1.5

ISRRS

Landsat MSS Data (CCT) (Required by ISRRS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - These data will consist of four channels of Landsat multispectral scanner data extracted to cover the 5- x 6-nm (9 x 11 km) sample segments specified in the JSC interface tape. Data will be in the format described by the JSC-GSFC Interface Control Document.

6.1.6

SPE

- A. DAPTS-Landsat Resource Parameters (Required by SPE; Category 2; Implementation Responsibility: DAPTS/NASA-GSFC) - Resource information utilized in the preprocessing transmission of data from GSFC to JSC will be monitored and recorded on a quarterly basis, broken into monthly increments and available on an "as requested" basis.
- B. Weekly Data Status Report - Monitor and record on a weekly basis the following Landsat data acquisition information:
 - 1. The number of attempted sample segment acquisitions and the number acquired. (Required by SPE; Category 2; Implementation Responsibility: DAPTS/NASA-GSFC).

2. The number of sample segments processed. (Required by SPE; Category 2; Implementation Responsibility: DAPTS/NASA-GSFC).
3. The number of daily segment tapes sent to JSC/EOD in support of LACIE operations. (Required by SPE; Category 2; Implementation Responsibility: DAPTS/NASA-DSAD).
4. The number of daily segment tapes reordered/reprocessed. (Required by SPE; Category 2; Implementation Responsibility: DAPTS/NASA-DSAD).

6.1.7 IE
Not applicable.

6.1.8 Research
(Req'd by Research; Cat. 4; Impl. Resp.: DAPTS/NASA-GSFC)

- A. Landsat MSS Full-Frame Data (CCT) - Pull Frame CCT's in four parts shall be output to satisfy stated requirements of the Research operation. These CCT's will correspond to the standard Landsat product for principal investigators. Landsat black-and-white transparencies (9.5 inches and 70 millimeters) over all the intensive test sites for the 1973-76 growing season for which cloud cover is less than 30 percent.
- B. Set of controlled mosaics made from band 5, Landsat-1 and 2 MSS data acquired during the "green phase" over each LACIE country. These data are to be used for task 4.1.1.1a (Req'd by Research; Cat. 1; Impl. resp.: DAPTS/NASA-SEAD-FSO).

6.1.9 Test and Evaluation
(Req'd by Test and Eval.; Cat. 4; Impl. Resp.: DAPTS/NASA-GSFC)

Landsat MSS Full-Frame Data (CCT) - Pull-frame CCT's (in four parts) shall be output as required to satisfy stated requirements for test and evaluation activities. These CCT's will correspond to the standard Landsat data product for principal investigators.

6.1.10

Accuracy Assessment

- A. Landsat MSS Calibration Documentation
(Required by Accuracy Assessment; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - Documentation is required on the GSFC calibration procedures for LACIE data; in particular, the procedure for replacement of data due to out-of-sync conditions and the relationship of the radiometric error versus the signal strength or spectral energy level.
- B. Landsat MSS Registration Documentation
(Required by Accuracy Assessment; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC) - Documentation is required on the GSFC registration procedures for LACIE; in particular, the definitive procedures used in both the automatic and manual modes, the error analysis study supporting the registration accuracy requirements, and a further definition of the origin of the header record information pertaining to registration.
- C. Registration Accuracy Report (Required by Accuracy Assessment; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD) - The DAPTS is required to determine the GSFC registration accuracy on a periodic basis for a number of the LACIE segments needed to make a valid statistical inference of the registration accuracy. A semiannual report is required which presents the results of the registration accuracy analysis.

6.2

INTERIM SYSTEMS

The output requirements for the interim system are the same as those specified for the full-up system.

SECTION 7.0
INTERFACE REQUIREMENTS (DOCUMENTS)

Each implementing organization shall comply with the interface requirements specified in the following documents:

- A. Earth Resources Data Format Control Book, Document PHO 543, July 1973.
- B. GSFC/JSC Interface Control Document for LACIE, March 20, 1975.

THIS PAGE BEING NOT SHOWN

~~LEADING PAGE BLANK: NOT BLANK~~

SECTION 8.0
OPERATIONAL REQUIREMENTS AFFECTING THE DESIGN

- 8.1 **THROUGHPUT REQUIREMENTS**
(Req'd by CAMS; Cat. 1; Impl. Resp.:
DAPTS/NASA-GSFC)
The system must provide the capability to turn out 100 samples per day.
- 8.2 **RESPONSE REQUIREMENTS**
(Req'd by CAMS; Cat. 1; Impl. Resp.:
DAPTS/NASA-GSFC and CAMS)
A maximum time limit of 10 days from acquisition to CCT arrival at JSC will permit establishing reprocessing requirements within a reasonable time. One day (24 hours) of this 10-day period will be required for preprocessing at Goddard. A maximum of 8 days will be required between delivery of tapes to JSC and establishing reprocessing requirements.
- 8.3 **RELIABILITY REQUIREMENTS**
- 8.3.1 General Reliability
(Req'd by CAMS; Cat. 1; Impl. Resp.:
DAPTS/NASA-GSFC)
Systems reliability has been described in significantly different terms; however, for this purpose, the following definitions will be used:
A. Soundness of design
B. State of completeness
C. State of being undiminished in performance

This refers to the data quality aspects of the hardware, software, and the data base of the LACIE reprocessing system.
- 8.3.2 Hardware Reliability
(Req'd by DAPTS; Cat. 1; Impl. Resp.: DAPIS-
NASA-GSFC)
The performance of the hardware system can affect the quality of the data products. Thus, the reliability of the hardware system must be ascertained to assure the quality of the data. Reliability factors established during LACIE 1A and 1B shall be used to evaluate the hardware reliability for LACIE II.

8.3.3

Software Reliability

(Req'd by DAPTS; Cat. 1; Impl. Resp.: DAPTS-NASA-GSFC)

The reliability of the systems and applications software must be maintained and assured in the operating environment. It will be assumed that the original program specifications are correct and that the software has been properly implemented and executed. The performance of the software during LACIE 1A and 1B will be used to certify reliability for LACIE II.

8.4

SECURITY REQUIREMENTS

Not applicable

8.5

DELIVERY REQUIREMENTS

(Req'd by DAPTS; Cat. 1; Impl. Resp.:

DAPTS/NASA-DSAD and NASA-GSFC)

JSC sends controlling information and data to be included in the MSS tape header record to GSFC in machine-readable form. The initial conditions are sent on nine-track CCT, and changes are made on punch cards. MSS data tapes output from the NASA Data Processing Facility (NDPF) at GSFC are shipped to the Real-Time Computer Complex (RTCC) at JSC on a daily basis.

8.6

QUALITY ASSURANCE (QA) REQUIREMENTS

(Req'd by ASVTB; Cat. 1; Impl. Resp.: DAPTS)

The LACIE Quality Assurance Plan is being prepared under the direction of the Quality Assurance Manager. The in-line QA Functions will be implemented, in most cases, by the organization involved.

A set of Quality Assurance procedures has been prepared by each organizational element in LACIE and audited by Quality Assurance. This document, which will be published in the near future, will provide a QA baseline for each of the elements in LACIE.

8.6.1

General Requirements

The following general requirements should be considered during preparation of the Quality Assurance Plans.

- 8.6.1.1 Validation of modifications (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS NASA-GSFC).- Development of a mechanism is required for independent validation of all hardware, software, and procedural modifications prior to their implementation into the system. Benchmark tests should be developed, run off-line, and verified by a quality assurance group to ensure that the output is altered only in the way desired, if any. Likewise, it should be ensured that all other subsystems are unaffected, or, if they are affected, that they be appropriately informed with a sufficient lead time to enable revisions to take place. These revisions should also be benchmarked in a similar manner.
- 8.6.1.2 Sample segment data (Required by DAPTS; Category 1; Implementation Responsibility: ISRRS/NASA-DSAD).- All sample segment data received from GSFC should be screened for data quality prior to the initiation of production processing of the data. This will enable poor data to be detected at the front end of the system and will prevent processing of substandard data which would go undetected until the results of CAMS processing are known. It will enable data to be reordered sooner in the biological time frame and will give a better chance for successful acquisition and processing of good data in a timely manner.
- 8.6.1.3 Product delivery/receipt (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS-NASA/DSAD & NASA/GSFC).- Products delivered or received across organizational or subsystem interfaces should be checked.
- 8.6.1.4 Discrepancy reporting (Required by DAPTS; Category 1; Implementation Responsibility: ISRRS).- A method of reporting problems within the system is required. Discrepancy Reports (DR's) will be used to alert quality assurance, management, and operating units of any deficiencies in the system. The DR may be initiated by anyone, but its resolution will be coordinated by the QA group. The procedures to be followed in closing DR's are specified in

the LACIE Quality Assurance Procedures document.

8.6.1.5

Stop-work orders (Required by DAPTS; Category 1; Implementation Responsibility: ISRSS).-- When a unit has developed a major problem and is consistently producing an inferior product, more drastic action is required. A "Stop-Work Order" would be issued by the QA group based upon inspection of the product defect as reported by a DR or by inspection of a line or bench mark test. The Stop-Work Order would be signed by the respective QA operations, and unit managers. As a result, all operations in the affected area would stop immediately until the problem is corrected. The system would remain in a down condition until QA is satisfied, based upon a line test or benchmark test indicating that the system is capable of continuing its operations. At that time the Stop-Work Order would be formally lifted by the aforementioned managers, or at least the system would be put into a "conditional restart" mode, pending inspection of the first products produced.

8.6.2

Specific Requirements (DAPTS)
The following specific DAPTS related requirements shall be covered by the Quality Assurance Plans.

8.6.2.1

GSFC/JSC tape unit compatibility (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD).-- The compatibility of GSFC and JSC magnetic tape units (MTU's) must be periodically verified independently of the transmission of actual data. Such things as skew angles, parity errors, inter-record gaps, and general read-write performance of the MTU's should be checked. Standards of performance require definition, and procedures need to be developed specifying the action to be taken when deviations are detected.

8.6.2.2

GSFC/JSC Interface Control Document (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD).-- The adherence to provisions of the GSFC/JSC ICD requires

periodic verification. Development of quality assurance procedures is required for incoming data as well as for data being supplied to GSFC by JSC.

8.6.2.3

DAPTS inputs from GSFC (Required by CAMS; Category 1; Implementation Responsibility: DAPTS/NASA-GSFC).-- Inputs received from GSFC will include Landsat multispectral scanner (MSS) computer tapes and status information concerning whether or not a segment has been acquired, whether an order exists for acquisition/processing in the GSFC data base, reasons for data rejection, and whether or not processing has been completed.

8.6.2.4

CCT checks (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD).-- Upon receipt of the CCT, the physical tape serial number and the tape identification number should be checked against the GSFC Magnetic Tape Receipt to ensure proper tape accountability. Also, it must be verified that the tape, as labeled, is a JSC LACIE input tape. Subsequent audits should also be made of the logging operation, to ensure that the tape numbers are correct. Periodic physical audits should be made of the Library to ensure that the tape logs represent physical reality and to account for any discrepancies. Quality checks are to be performed on the input CCT to assure that the tape and data meet the processing standards of JSC. Checks should be made for read/parity errors, format errors, physical tape errors, proper end-of-file (EOF) marks, and continuation flags.

Subsequent to duplication of the data tape, the duplicate tapes should be compared with the original data to ensure a one-to-one correspondence between them. The tape label identification of the duplicate tapes should be verified. The header record of each file should be accessed and the site identification, tape identification, data quality, number of out-of-sync conditions, cloud cover, and JSC film processing information should be verified. The center point coordinate of each site should

be compared with the expected values at that time. Each sample segment flagged for processing by the Production Film Converter (PFC) should be listed for a subsequent check of its output.

- 8.6.2.5 Status report checks (Required by DAPTS; Category 1; Implementation Responsibility: NASA-DSAD).- The GSFC processing information transmitted to JSC should be checked for completeness upon receipt; i.e., segment acquisition status, rejection code, and processing status.
- 8.6.2.6 DAPTS transmissions to GSFC and NOAA (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- Data tape and card updates to the GSFC acquisition/processing data bases will be output by DAPTS to accommodate such items as specifications of sample segment coordinates, confirmation of data receipt, specification of training segments, countries, and biological windows. Additionally, data tape reorders for checking quality rejections will be output to GSFC and to the National Oceanic and Atmospheric Agency (NOAA).
- 8.6.2.7 Acquisition requests (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-FSO).- This subsystem must ensure that the GSFC acquisition requests specify the correct coordinates of the desired site and verify that the next available coverage is within the expected biological window.
- 8.6.2.8 Key punch operations (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- All key punch operations must be followed by a verifying operation.
- 8.6.2.9 Cards (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- Cards used to transmit data should be listed and checked for proper format, accuracy, and completeness.

ORIGINAL PAGE IS
OF POOR QUALITY

- 8.6.2.10 Data_tape (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- JSC creation of a data tape for GSFC should be verified to ensure that all data was actually loaded on the tape and that the tape contains no physical errors which would preclude its usefulness at GSFC.
- 8.6.2.11 Data_quality_reorders (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- Data being reordered should be checked against an output error analysis report to verify that it was either missing or outside established limits.
- 8.6.2.12 Missing_data_reorders (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- All unsatisfied requests for data should be double-checked before reordering to ensure that they were caused by nonreceipt as opposed to a logging error.
- 8.7 OTHER OPERATIONAL REQUIREMENTS
Precautionary measures must be taken to ensure that data requirements are met without excessive data processing and that substitutions are properly noted.
- 8.7.1 General_Precautions
Precautions will apply to both electronic data and nonelectronic data. This section identifies those precautions that relate to data quality.
- 8.7.2 Data_Receipt
(Req'd by DAPTS; Cat. 1; Impl. Resp.: DAPTS/NASA-DSAD)
A procedure for receiving data must be developed that will assure proper measures are in effect. As a minimum, the following points should be checked:
- A. Actual receipt
 - B. Verification of contents
 - C. Logging of data
 - D. Notification of receipt by the system
 - E. Temporary storage
 - F. Distribution

- 8.7.3 Data Accountability
(Req'd by DAPTS; Cat. 1; Impl. Resp: NASA-DSAD)
Assurance should be made that the logs reflect the disposition of the data and the authorization for release.
- 8.7.4 Transmittal of Data Products
Upon the transmittal of all data products, checks should be made to assure that the system is intact.
- 8.7.4.1 Authorization (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD).- It must be ascertained that the receiving agency personnel are authorized to receive the data. All distribution lists must be checked to assure proper routing of data.
- 8.7.4.2 Shipping (Required by DAPTS; Category 1; Implementation Responsibility: DAPTS/NASA-DSAD & NASA-GSFC).- LACIE data should be shipped in containers designed to preserve the quality of the data.

~~NOG. PAGE 41444: NOT. 41444~~

SECTION 9.0

VERIFICATION REQUIREMENTS

Each organization designated with implementation responsibility shall prepare a LACIE Verification Plan, including a complete definition of the verification functions proposed for verification of the portion of LACIE for which it is responsible. Each organization shall submit their plan for approval to the LACIE Level III change board within 90 days after the requirements documents are baselined. (Required by ASVB; Category 1; Implementation Responsibility: DAPTS). As a minimum, the verification plan shall include the following related to the DAPTS subsystem:

- A. Each module of the hardware/software package shall be functionally verified before integration into the preprocessing subsystem. (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC).
- B. A test JSC Interface Tape will be compiled in the format prescribed in the ICD and transmitted to GSFC to activate the GSFC acquisition-preprocessing operation. (Required by DAPTS; Category 1; Implementation Responsibility: NASA/DSAD). GSFC will, in response, submit test data tapes that are output in various stages of checkout of the GSFC hardware/software modifications. These tapes will contain data in the format prescribed by the ICD and will normally result in increasing amounts of real data being introduced as the system nears a "full-up" status. (Required by DAPTS; Category 1; Implementation Responsibility: NASA/GSFC).
- C. A spot check will be made of a portion of the sample segments having undergone preprocessing for the November System (Phases 1A and 1B). This check for positional accuracy will entail locating the center point of these segments with respect to the map coordinate system (ONC's), and a record will be made of the discrepancy in Landsat and map coordinates. (Required by DAPTS; Category 1;

Implementation Responsibility: NASA-
SEAD/PSO).

- D. A spot check will be made of the initial Phase 1A and 1B imagery to verify that the registration module of the subsystem is working properly. This initial check will use overlaid transparencies and visual analysis of the resultant match to verify that the correlation algorithm is finding the proper match point and that the registration algorithm is performing properly. (Required by DAPTS; Category 1; Implementation Responsibility: CAMS).

SECTION 10.0
RESEARCH REQUIREMENTS

The DAPTS subsystem requires the following research to be conducted:

Alternate Techniques for Correlation and Registration -

- A. The investigation of the use of alternate correlation algorithms on LACIE type data should be pursued. This investigation should continue until the present correlation and registration technique is satisfactory. (Required by DAPTS; Category 1; Implementation Responsibility: NASA-SEAD/BTE[LARS]).
- B. Full-frame registration - Full-frame registration has been identified as a possible requirement for LACIE. Although the firm requirement does not exist, the possibility for requiring and using this technique seems real enough to support research related to this mode of registration. It is not envisioned that the results of this research will feed directly into the initial full-up version of the LACIE processing system, but that the results would be available to support development of some follow-on version of the system. In conjunction with this line of research, activity is required in the following areas:
 1. Development of efficient algorithms to perform the registration on a full-frame basis. Candidates might include the linear or low-order piecewise fit, with continuity between pieces, and a global treatment using a higher order polynomial. (Required by DAPTS; Category 2; Implementation Responsibility: NASA-SEAD/BTE).
 2. In conjunction with full-frame registration, a number of allied topics need to be investigated. These include the problem of finding reasonably stable (radiometrically) kinds of things in a Landsat image for use as control points to support either image-

to-image or image-to-ground registration. (Required by DAPTS; Category 2; Implementation Responsibility: NASA-SEAD/RT&E).

3. An additional problem connected with full-frame registration is that of generating, storing, and using ground control points. An investigation should be performed to find a suitable and efficient algorithm for extracting map coordinates for appropriate points, storing these points as part of a data base, and automatically calling up the desired points for a given frame of data. In addition, the algorithm should correlate the stored point with the corresponding image point, introduce the stored ground coordinate information, and generate transformation coefficients that provide a means for locating any pixel with respect to the ground, or vice versa. (Required by DAPTS; Category 3; Implementation Responsibility: NASA-SEAD/RT&E).

- C. Registration capability of the Image 100 (Required by DAPTS; Category 2; Implementation Responsibility: NASA-SEAD/RT&E) - The Image 100 may have some application as a backup system for LACIE processing. One of the functions that should be considered for inclusion is the capability to perform registration of the temporally separated LACIE data sets. This would entail investigating many of the same aspects of data registration discussed in the paragraph above, but in the special context of the Image 100 system and 5- x 6-nm (9 x 11 km) data sets. Investigation topics should also include such things as input/output requirements, throughput rates, methods of reducing the size of the search area (currently 10 x 11 nm (18.5 x 20 km)), and consideration of special hardwired correlation devices.

SECTION 11.0
TEST AND EVALUATION REQUIREMENTS

The DAPTS subsystem requires the following test and evaluation to be conducted:

- A. Alternate Techniques for Correlation and Registration (Required by DAPTS; Category 2; Implementation Responsibility: NASA/SEAD-FSO/RT&E) - Alternate correlation/registration algorithms developed under the research program, discussed in the first subparagraph of section 10, shall be tested and evaluated using Landsat data in 5- x 6-nm (9 x 11 km) format. This testing and evaluation shall consist of a quantitative assessment of registration accuracy in terms of number of pixels of misregistration at a number of points in the registered image. The throughput rate of the algorithm shall also be evaluated in terms of its ability to support LACIE on available hardware systems.
- B. Full-Frame Registration (Required by DAPTS; Category 2; Implementation Responsibility: NASA/SEAD-RT&E) - The accuracy of a full-frame registration of Landsat data shall be tested by checking for misregistration at a large number of points in the registered frames. An assessment of throughput rates on available systems shall also be made, along with an assessment of the capability to support the LACIE operation with the candidate full-frame registration algorithm.
- C. Registration capability of the Image 100 (Required by DAPTS; Category 2; Implementation Responsibility: NASA-SEAD/RT&E) - A test and evaluation shall be conducted of any algorithm developed and implemented on the IMAGE 100 system in support of LACIE. Assuming that a hardwired Fourier Transform technique is employed, the assessment will include a quantitative evaluation of the accuracy and reliability of the resulting correlations on LACIE type Landsat data. The evaluation

will also consider the throughput rate achievable on the Image 100.

- D. Cloud Cover Detection Algorithm (Required by DAPTS; Category 2; Implementation Responsibility: NASA/SCAD-RT&E) - The cloud cover detection algorithm used by GSFC will be evaluated by visual analysis of extracted portions of full coverage CCT's in which 10- x 11-mile segments having varying amounts of cloud cover have been identified. The results of the visual analysis will be compared with the percentage of cloud cover listed by GSFC for that particular segment.